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CFD simulation of Near Wall Turbulence and Heat Transfer of Molten Salts

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Abstract : New generation nuclear power plants are currently being developed to be highly economical, to be passive safe, to produce hydrogen. An important feature of these reactors will be the use of coolants at temperature higher than that being used in current nuclear reactors. The molten fluoride salt with a eutectic composition of 46.5% LiF - 11.5% NaF - 42% KF (mol %) commonly known as FLiNaK is a leading candidate for heat transfer coolant for these nuclear reactors. CFD simulations were carried out using large eddy simulations to investigate the flow characteristics of molten FLiNaK at 850°C at a Reynolds number of 10,500 in a cylindrical pipe. Simulation results have been validated with the help of mean velocity profile using direct numerical simulation data. Transient velocity information was used to identify and characterise turbulent structures which are important for transfer of heat across solid-fluid interface. A wavelet transform based methodology called wavelet transform modulus maxima was used to identify and characterise the singularities. This analysis was also used for flow visualisation, and also to calculate the heat transfer coefficient using small eddy model. The predicted Nusselt number showed good agreement with the available experimental data.

Keywords : FLiNaK, heat transfer, molten salt, turbulent structures
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